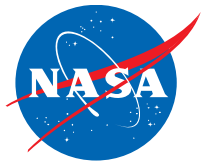

Percutaneous Drainage Capability for Deep Space Exploration

89th Annual Scientific Meeting of the Aerospace Medical Association

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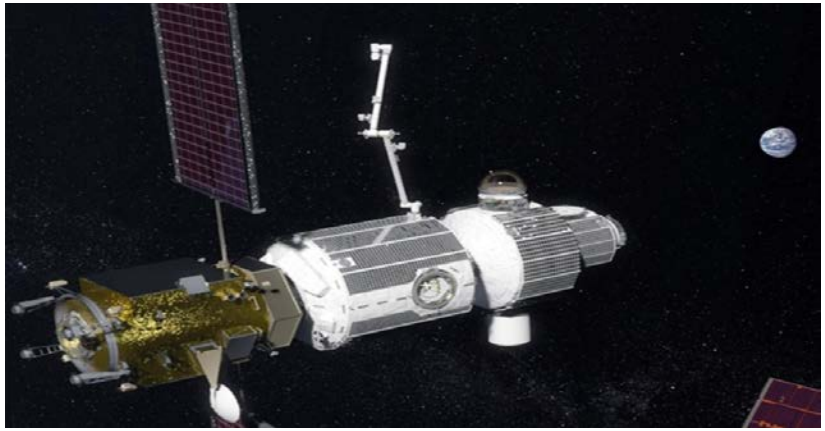
Disclosure Information

AsMA 89th Annual Scientific Meeting

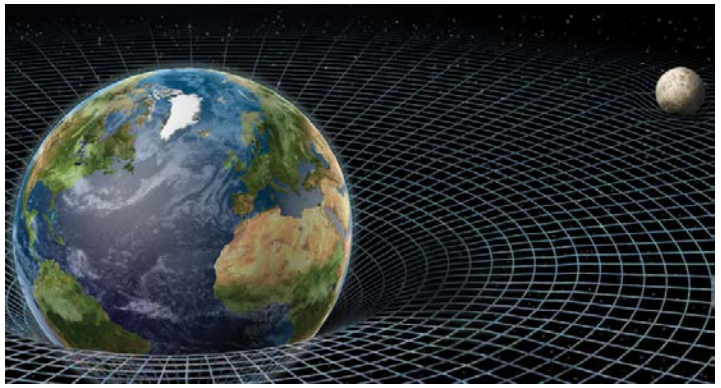
- We have no financial relationships to disclose
- We will not discuss off-label use or investigational uses

Objectives

- Discuss current evidence based capabilities of percutaneous drainage (PCD) for spaceflight



Exploration Medical Capabilities (ExMC)



- Expanding capability beyond LEO
- New challenges
  - No evacuation
  - Communication delays
  - Mass/volume constraints
- Need robust autonomous capabilities

"Evidence Report: Risk of Adverse Health Outcomes and Decrements in Performance due to In-Flight Medical Conditions," 2017

Percutaneous Drainage

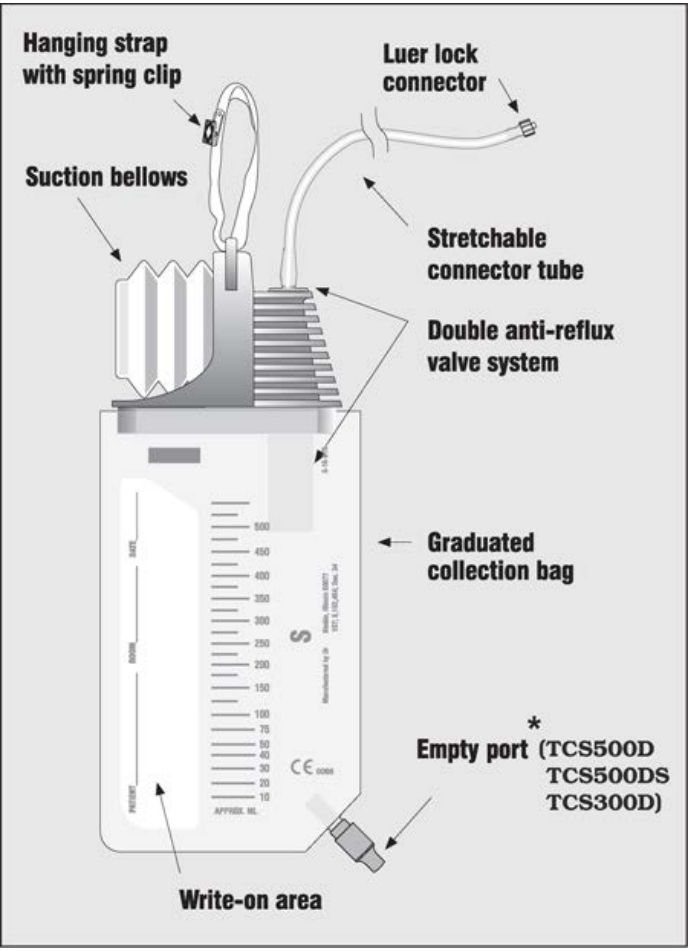
- Drainage of fluid, abscess or air
- Needle or catheter placement
- Often with image guidance
- Benefits
  - Preferred for many conditions
  - Simple
  - Repeatable
  - Minimally invasive

Equipment

- Low mass and volume
- Alternate medical/non-medical uses
- Ultrasound Imaging likely imaging modality
- Ongoing development
  - Flow is reduced at 0G compared to 1G[1]

[1]L. Brown, Personal Communication, October, 23,2017

Equipment


Hanging strap with spring clip
Luer lock connector
Suction bellows
Stretchable connector tube
Double anti-reflux valve system
Graduated collection bag
* Empty port (TCS500D TCS500DS TCS300D)
Write-on area

Training and Currency: MicroG

- Standard sterile technique
- Tubing and equipment tethering
- Altered fluid mechanics
- Abdomen tends to “circularize”[1]
- Parabolic flight tests
  - Successful aspiration of intra-peritoneal fluid
  - No more demanding than 1-G rehearsals
  - Fluid collections more distinct from surrounding viscera[2]

[1]Surgical Capabilities for Exploration and Colonization Space Flight,” 2015.
[2]A W Kirkpatrick et al., 2002

Training and Currency: Deep Space

- Non-physician versus physician astronaut
- Emergency Physicians (ACEP) training guidelines:
  - **Sixteen** to **twenty four** hours[1]
- ISS FAST exam trial: successful exam with
  - **three** hours of familiarization
  - **two** hours hands on training[2]
  - Non medical crew
- Augmented reality computer based simulations[3]
  - May provide ongoing review and training on mission

[1]Emergency Ultrasound Guidelines,2009
[2]Sargsyan et al.,2005
[3]Magee et al., 2007

Percutaneous Drainage

- Integrated Medical Model (IMM) conditions:
  - Appendicitis
  - Acute Cholecystitis
  - Chest Injury
  - Abdominal Injury
  - Urinary Retention
  - Hydronephrosis (kidney stone)

Appendicitis

- Percutaneous drainage
  - Only intervention available in ExMC
  - Ruptured appendix and intra-abdominal abscess
  - 64% success rate with US guided drainage[1]
- Recent meta-analysis:
  - Antibiotic treatment comparable to appendectomy
  - 72% antibiotic success rate[2]
  - 14.2 to 20% subsequent surgical appendectomy[3]
- Modification of success rates needed
  - Healthy crew
  - Quick treatment and no surgical option

[1]Fagenholz et al., 2016
[2]Zhi-Hua Liu, 2014
[3]Flum, 2015

Home Remedies for Appendicitis

Castor Oil Remedy

1. Fold a large flannel cloth into layers and pour 2 tbsp castor oil on it.
2. Lie down on an old towel & put the flannel cloth on your abdomen.
3. Repeat this remedy 3 times a week for 2 to 3 months.

Garlic

Ginger

Fenugreek Seeds

Lemon

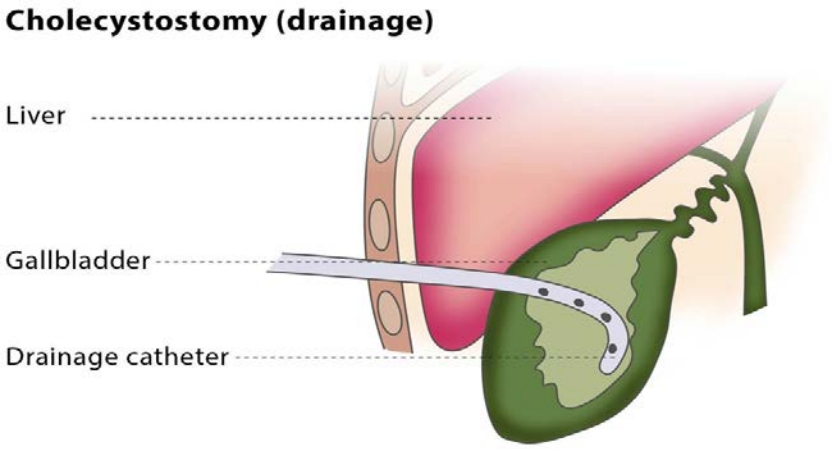
Mint

Top 10 Home Remedies

To explore more, visit www.Top10HomeRemedies.com

Acute Cholecystitis

- Drainage via perc. transhepatic cholecystostomy
- Can be definitive procedure
- 94 % technical success rate
- 86 % procedural success rate
- US lower complication /death rate versus fluoroscopy



Wagner et al., 2017

Hemothorax/Pneumothorax

- 100 % Success with pneumothorax
- 80 % Success with loculated pleural effusions[1]
- Successful with different pleural fluids
- Studies found minimal complications
- Significant clinical improvement[2]

[1]Bediwy & Amer, 2012; Liu et al., 2010
[2]Aziz, Penupolu, & Flores, 2012

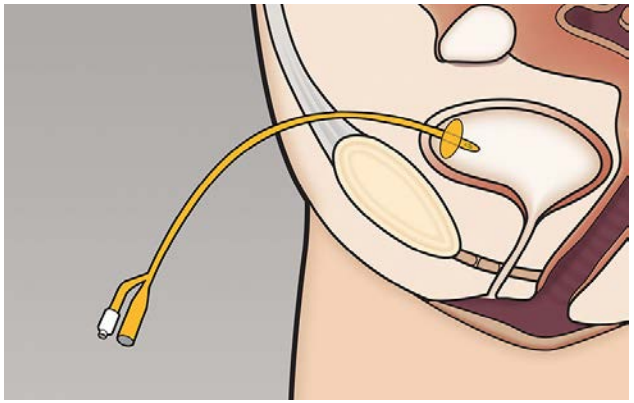
Abdominal Compartment Syndrome

- Intra-abdominal pressure >12 mm hg
- Possible etiologies in spaceflight[1]
    - Abdominal trauma
    - Hemorrhage
    - Intestinal obstruction
    - Large Burns
- Percutaneous drainage preferred over laporotomy[2]
- PCD is safe and effective in preventing ACS in burn patients[3]

[1]Backer, 1999
[2]Kirkpatrick et al., 2013
[3]Latenser et al., 2002

Urinary Retention

- Suprapubic catheterization safely performed in remote areas by non-physicians[1]
- Study showed suprapubic catheterization to be:
  - Quick procedure
  - High success rate
  - Minimal complications
  - Recommended after 2 or 3 failed transurethral attempts[2]



[1]Gujral, Kirkwood, Hinchliffe, & Gujral, 1999
[2] Bilehjani E & Fakhari S, 2017

Hydronephrosis

- Kidney stone usual cause
- Found in 89 % of suspected stone[1]
- US guided placement success rate 96%[2]
- Complete urinary obstruction
  - One week-complete recovery of kidney function
  - Twelve weeks- Non recoverable kidney damage

[1]Song et al., 2016
[2]Lodh et al., 2014

Complications

- Infection
- Bleeding
- Nephrostomy complication rate 10% [1]
- Abdominal PCD complications < 5%
- Bowel puncture with 21 g needle “inconsequential” in most cases[2]

[1]Pabon-Ramos et al., 2016
[2]Lorenz & Thomas, 2006

Further Research

- Risk mitigation
  - Guidance and training
  - Physician-astronaut utilization
- Optimal catheter size and materials
- 3D printing of supplies

PCD Conclusions

- Achievable skill by physician and non-physician
- Small overall resource burden
- Treat surgical conditions that can occur in spaceflight
- Many advantages of a robust procedural capability
- Decreases mission risk

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Thank You

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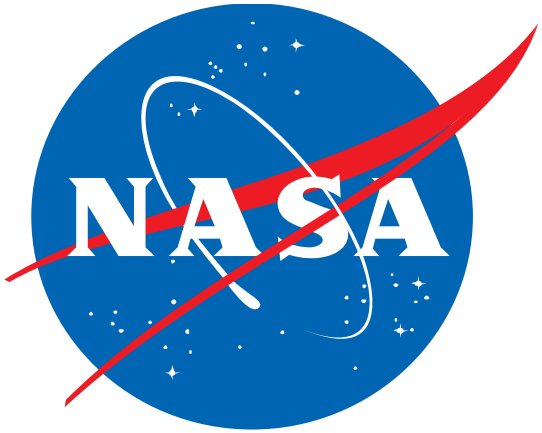
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